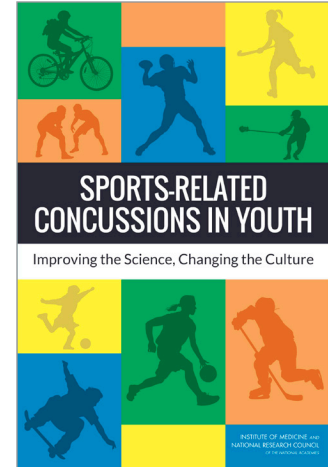


# EXHIBIT 9

# Sports-Related Concussions in Youth

## Improving the Science, Changing the Culture



**In the past decade,** few subjects at the intersection of medicine and sports have generated as much public interest as sports-related concussions—especially among youth. Despite growing awareness of sports-related concussions and campaigns to educate athletes, coaches, physicians, and parents of young athletes about concussion recognition and management, confusion and controversy persist in many areas.

The Institute of Medicine (IOM) and the National Research Council (NRC), supported by a number of government agencies and private groups, convened an expert committee to review the science of sports-related concussions in youth from elementary school through young adulthood, as well as in military personnel and their dependents. The committee was asked to recommend actions that can be taken by a range of audiences—including research funding agencies, legislatures, state and school superintendents and athletic directors, military organizations, and equipment manufacturers, as well as youth who participate in sports and their parents—to improve what is known about concussions and to reduce their occurrence.

*Sports-Related Concussions in Youth: Improving the Science, Changing the Culture* finds that while some studies provide useful information, much remains unknown about the extent of concussions in youth; how to diagnose, manage, and prevent concussions; and the short- and long-term consequences of concussions as well as repetitive head impacts that do not result in concussion symptoms.

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## Charting the Unknowns

Currently, there is a lack of data concerning the overall incidence of sports-related concussions in youth, although the number of reported concussions has risen over the past decade. A number of factors may have contributed to this increase, including more awareness and better recognition of such injuries.

Among male athletes at the high school and collegiate levels, football, ice hockey, lacrosse, wrestling, and soccer consistently are associated with the highest rates of concussions. Among female athletes, high school and collegiate sports associated with the highest rates of concussions are soccer, lacrosse, basketball, and ice hockey. There has been little research on the frequency of concussions among athletes in intramural and club sports and in athletes younger than high school age.

To help close data gaps, the committee calls for the Centers for Disease Control and Prevention to establish and oversee a national surveillance system to accurately determine the incidence of sports-related concussions, including those in youth ages 5 to 21. Data should be collected on a range of factors related to the participants, including their demographic information, concussion history, and use of protective equipment. Also, data should be collected on the cause, nature, and extent of the concussive injury, including on the sport or activity, level of competition and type of event, impact location on the body, nature of impact—such as contact with another player or equipment—and signs and symptoms observed that are consistent with a concussion.

## Understanding Diagnosis, Recovery, and Health Effects

Although some research indicates that a series of molecular and functional changes take place in the brain following injury, little research has been conducted specifically on changes in the brain following concussions in youth or on the differences

in such changes between females and males. The diagnosis and management of concussion, as well as the measurement of recovery, also remain unsettled. Currently, diagnosis is based primarily on the symptoms reported by the individual rather than on objective diagnostic markers, and there is little empirical evidence for the optimal degree and duration of physical rest needed to promote recovery or the best timing and approach for returning to full physical activity. The committee therefore recommends that the National Institutes of Health (NIH) and Department of Defense (DoD) support research to establish objective, sensitive, and specific metrics and markers of concussion diagnosis, prognosis, and recovery in youth and to inform the creation of age-specific, evidence-based guidelines for the management of short- and long-term health consequences of concussion in youth.

Studies of the shorter-term effects of repetitive head impacts and multiple concussions have had mixed results; some studies show that these injuries result in a decrease in cognitive function—such as memory loss—and changes in brain physiology while others do not. The role that multiple concussions and repetitive head impacts play in long-term health also is not fully understood. For example, it remains unclear whether repetitive head impacts and multiple concussions sustained in youth lead to long-term neurodegenerative diseases, such as chronic traumatic encephalopathy—commonly known as CTE—and Alzheimer's disease.

To this end, the committee recommends that NIH and DoD conduct controlled, longitudinal, large-scale studies to assess short- and long-term consequences of concussions and repetitive head impacts over the life span. Research should include an examination of the effects of concussions and repetitive head impacts on quality of life and daily activities. It is critical that such studies identify predictors and modifiers of outcomes, including the possible influence of socioeconomic status, race and ethnicity, sex, and co-occurring conditions.

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## Improving Safety Standards and Equipment Design

Enforcing rules and standards for safe play can help to reduce the occurrence of sports-related injuries. Though there is some evidence that rules and playing standards can affect the incidence of concussions in youth sports, there is a need for much more research on this. Toward this goal, the committee recommends that the National Collegiate Athletic Association (NCAA), in conjunction with the National Federation of State High School Associations (NFHS), national governing bodies for youth sports, and youth sport organizations undertake a rigorous scientific evaluation of the effectiveness of age-appropriate techniques, rules, and playing and practice standards in reducing sports-related concussions and any resulting conditions. DoD should conduct equivalent research for sports and physical training—including combatives—at military service academies and for military personnel.

Designing more effective safety equipment may offer another route to protecting youth from concussions. The committee finds limited evidence that current helmet designs reduce the risk of sports-related concussions and no evidence that mouthguards or facial protection reduce concussion risk, although such protective equipment protects against other injuries, such as skull fractures and injuries to the mouth and face. The committee recommends that NIH and DoD fund research on the biomechanical factors that influence injury risk in youth, including how one's likelihood of being injured may be modified by

the number of repetitive head impacts and concussions he or she sustained in the past, as well as the amount of time that has passed since prior injury.

These data are critical for informing the development of effective protective equipment and equipment safety standards, impact-monitoring systems, and athletic and military training programs.

## Changing the Culture

The culture of sports negatively influences athletes' self-reporting of concussion symptoms and their adherence to return-to-play guidance. Athletes, their teammates, and, in some cases, coaches and parents may not fully appreciate the health threats posed by concussions. Similarly, military recruits are immersed in a culture that includes devotion to duty and service before self, and the critical nature of concussions may often go unheeded. If the youth sports community can adopt the belief that concussions are serious injuries and emphasize care for players with concussions until they are fully recovered, then the culture in which these athletes perform and compete will become much safer.

Most states have laws with requirements for concussion education for athletes and parents, criteria for removal from play, and medical clearance for returning to play. However, there is variation among states in the specific educational requirements for coaches, student athletes, and parents; qualifications of providers who are permitted to



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make return-to-play decisions; and populations to which the legislation applies. Research indicates that concussion education programs are effective for improving concussion knowledge and awareness, but there is little evidence that these programs change behavior.

The committee recommends that the NCAA and the NFHS, in conjunction with various other public and private groups, develop, implement, and evaluate the effectiveness of large-scale efforts to increase knowledge about concussions and change the culture—social norms, attitudes, and behaviors—surrounding concussions among elementary school through college-aged youth and their parents, coaches, sports officials, educators, trainers, and health care professionals. These efforts should take into account demographic variations—including socioeconomic status, race and ethnicity, and age—across population groups.

## Conclusion

Given the prevalence of youth sports participation in the United States, improving understanding of the extent, causes, effects, and prevention of sports-related concussions is vitally important for the health and well-being of youth athletes. The IOM and NRC hope that the findings and recommendations in this report will help in reaching this goal. 

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